3. Kindsvater, Carl E., "Discharge Characteristics of Embankment-Shaped Weirs," *Geological Survey Water-supply Paper*, 1617-A, U.S. Government Printing Office, Washington, D.C., 1964, p. A-47.

4. Mavis, F. T., "Submerged Thin-Plate Weirs," *Engineering News-Record*, July 7, 1949, pp. 65-69.

5. Poleni, Joannis, *De motu aquae mixto*, Patavii (Padua), 1717.

6. Rohwer, Carl, discussion, "The Improved Venturi Flume," *Transactions*, ASCE, Vol. 89, pp. 875-877 (1926).

7. Yarnell, David L., and Nagler, Floyd A., "Flow of Flood Water Over Railway and Highway Embankments," *Public Roads*, Vol. 11 (#2), pp. 30-34, April, 1930.

AUGUST R. ROBINSON,[16] F. ASCE.—The authors have presented a new design for flow measuring flumes. The flumes have a rectangular section and flat bottom, and do not have a throat section such as is provided for conventional measuring flumes. The unique feature of this design is the standard sidewall sections, which are used for all flumes ranging from 1 ft to 6 ft in throat width. In other words, the same design and length of converging and diverging sections are used for all throat widths. The authors state that "the use of a consistent geometric shape allows accurate predictions of discharge ratings for intermediate flume sizes." In addition to the rectangular flumes presented in this paper, the authors also have designed and calibrated trapezoidal cutthroat flumes that do not have a throat section.[8] The simplicity of the flumes is obvious and, from the information presented by the authors, it appears that they have many desirable features. The extent of field experience with the device is not given. It is assumed that the authors have had experience other than the laboratory calibrations in order to observe any particular field problems which are not apparent under laboratory conditions.

In a discussion of an earlier paper by the authors[9] a number of questions were posed by the writer regarding the analysis, particularly for the submerged flow case. Since the same type of analysis was used for the cutthroat flumes, the same questions apply here. In addition, there are other questions which should be clarified regarding the calibration of the cutthroat flume. Eq. 1 presents the basic free-flow equation. The value of C is shown to vary for each particular width of flume. However, the exponent of h_a is stated as being a constant of 1.56. It is difficult to understand how the exponent can be constant for flume sizes varying from 1 ft to 6 ft in throat width, all of which have the same sidewalls. For Parshall flumes over the same size range, the published calibration equations show a constant value of 4.0 for the discharge coefficient but the exponent increases with throat width. If the same sidewalls are used for all throat widths, the amount of contraction varies from 3 to 1 for the 1-ft size to 1.33 to 1 for the 6-ft flume with the head measured at the same distance upstream from the narrowest point in all cases. In general, this would result in a variation of the exponent of the depth, with the coefficient of discharge varying not only with width of section but also with depth of flow. Obviously the authors have fitted a regression curve with the same slope to the data for each flume, which is acceptable provided that the deviation of actual flow to computed discharge does not exceed a certain acceptable limit. It would be interesting if the authors gave information on the standard deviation as well as maximum percent deviation of calculated discharge to actual discharge for each flume. In this manner, the user could assess the

[16] Agric. Engr., U.S. Dept. of Agric., Agric. Research Service, Snake River Conservation Research Center, Kimberly, Idaho.

accuracy he could expect if the discharge equations with constant exponents are used.

The authors state that "one distinct advantage of removing the throat section was improved flow conditions in the exit section. The converging inlet section tended to confine the flow into a jet which traveled along the flume centerline, thus assisting in the prevention of flow separation." The statement on prevention of flow separation is not understood. Certainly if the flow is confined to a centerline jet, the flow "separates" from the sidewalls. The occurrence of a stable centerline jet does not correspond to observations such as early work by Parshall (8), who made many modifications to standard Parshall flumes including removal of the throat section, diverging section, and changes in the floor geometry. He concluded that "liberal modifications could be made with respect to the throat and diverging section of the structure without materially affecting the indicated rate of discharge, especially for the free-flow discharge." Parshall showed that removing the throat walls caused no material change in the free-flow equation of discharge, and the submerged flow data were not seriously different. He states that "detailed notes on this series indicated, however, that the current downstream shifted from one side of the channel to the other, probably because the guiding effect of the throat had been removed." Parshall was probably observing the so-called Coanda effect where the jet attaches to the wall due to the pressure distribution. It would be reasonable to expect that this phenomenon would occur for a structure such as that proposed by the authors.

It is interesting to compare the free and submerged flow relationships of this paper with one they previously published (9). Considering the 1-ft flume, the geometry of the flume in the earlier paper was much the same with the exception that it contained a long throat section (6 ft). Locations for the measurement of depths were slightly different in each case. For the earlier study[9] the free-flow relationship was given as $Q = 2.87\ h_a^{1.525}$. The limit of submergence is given as 89.3%. For the 1-ft cu throat flume, the discharge equation is $Q = 3.50\ h_a^{1.56}$ and the limit of submergence is 79.0%. The large difference in discharge coefficient can probably be explained. However, the difference in limit of submergence for each flume as a function of throat length should be analyzed. It appears that a long throat section may be advantageous, because the flume will operate under much higher submergence before corrections are necessary. Because submergence corrections are rarely made in the field, any device that can operate under high submergence without corrections is desirable. The authors' analysis and discussion of this point would be appreciated.

The authors are to be commended for proposing the new design of measuring flume. However, it appears that more extensive field experience is needed before the design can be fully evaluated. The economic feature of using standards sidewalls may be overshadowed by operational problems, as well as loss of accuracy.

Appendix.—Reference.

8. Parshall, R. L., "Tests of Modified Parshall Measuring Flumes," Progress Report, mimeo., United States Department of Agriculture, Bur. of Agric. Engrg., Ft. Collins, Colo., March, 1933, pp. 26.